July 18, 1961 H. E. BOWERMAN 2,992,955

ZERO VOLUME AIR TUBE AND METHOD OF MAKING

Filed Jan. 13, 1958 3 Sheets-Sheet 1

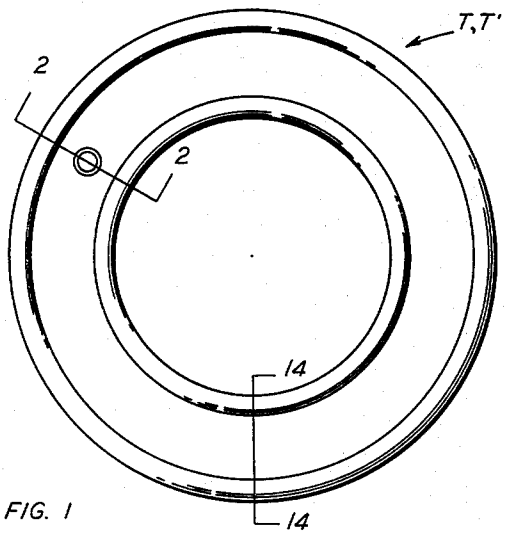


FIG. I

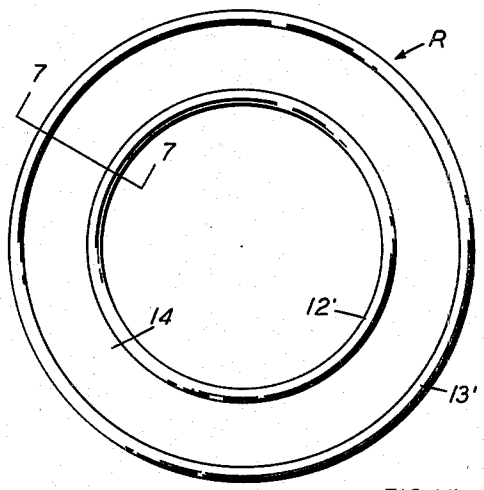


FIG. VI

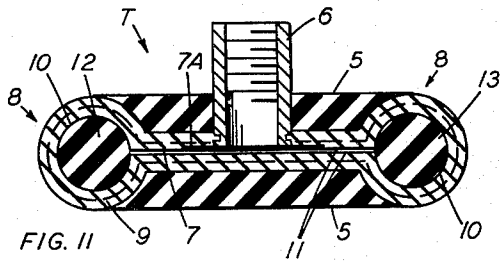


FIG. II

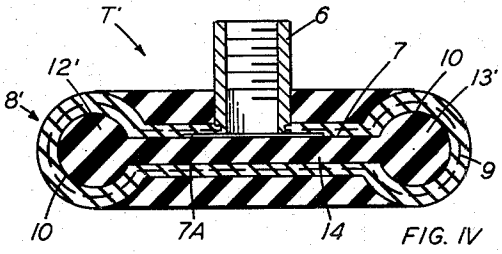


FIG. IV

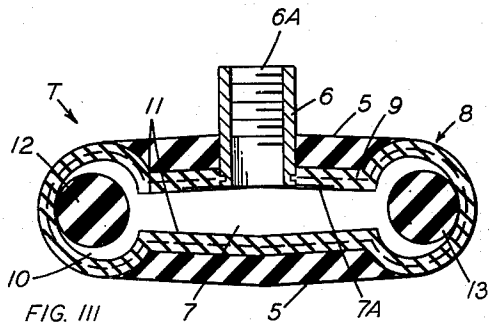


FIG. III

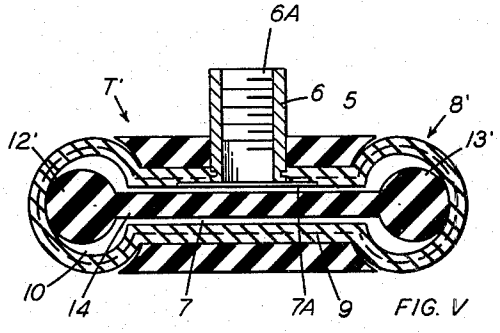


FIG. V

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July 18, 1961 H. E. BOWERMAN 2,992,955

ZERO VOLUME AIR TUBE AND METHOD OF MAKING

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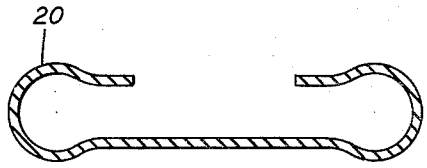


FIG. IX

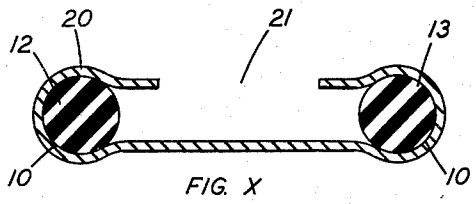


FIG. X

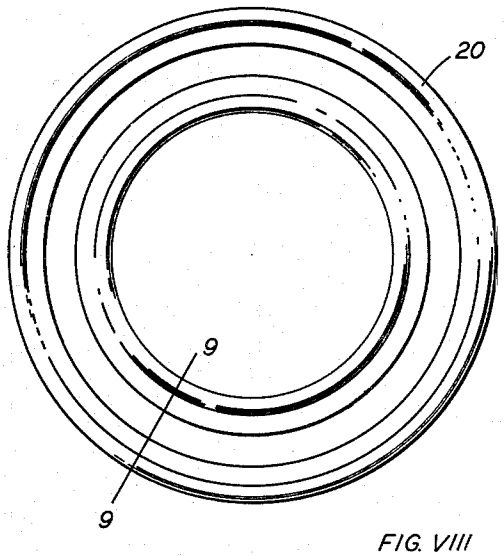


FIG. VIII

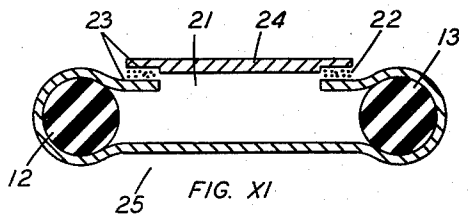


FIG. XI

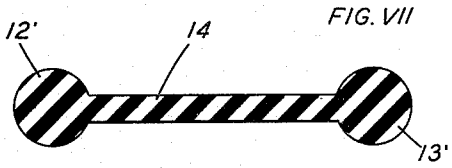


FIG. VII

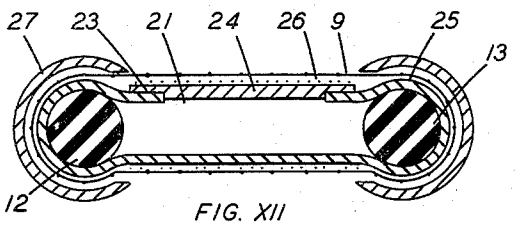


FIG. XII

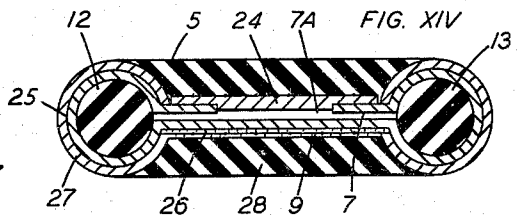


FIG. XIV

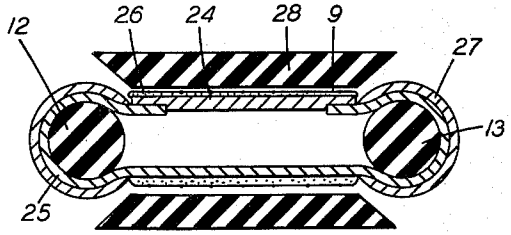


FIG. XIII

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ZERO VOLUME AIR TUBE AND METHOD OF MAKING

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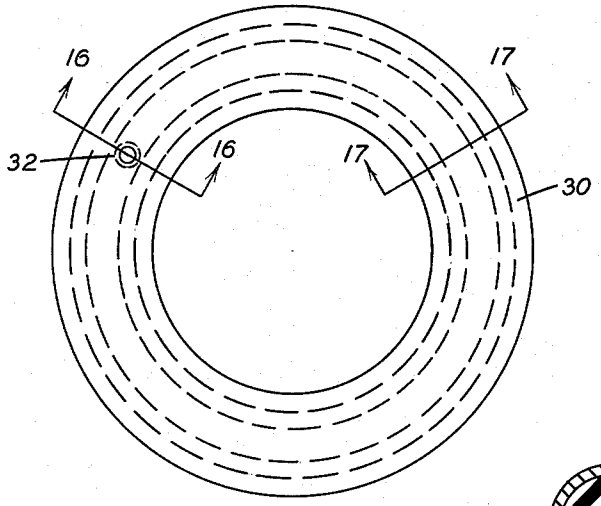


FIG. XV

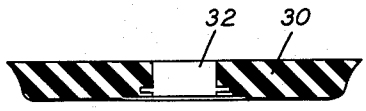


FIG. XVI

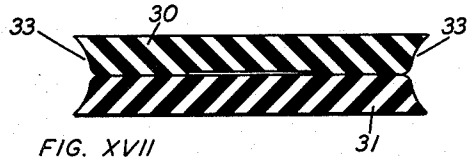


FIG. XVII

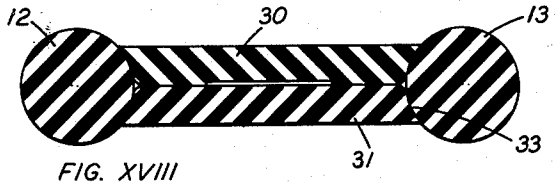


FIG. XVIII

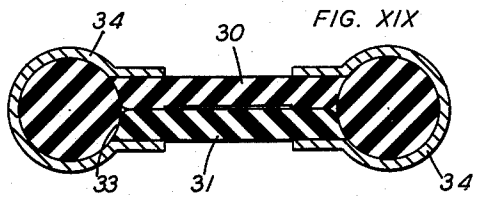


FIG. XIX

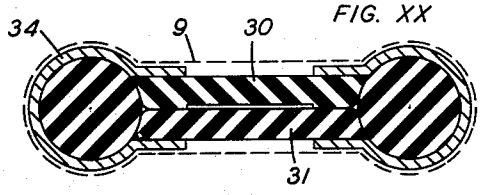


FIG. XX

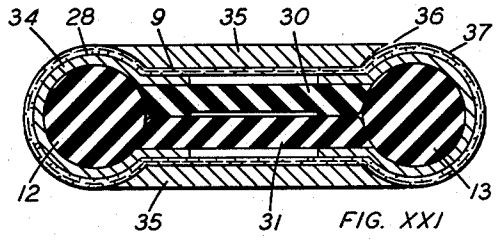


FIG. XXI

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United States Patent Office 2,992,955 Patented July 18, 1961

2,992,955
ZERO VOLUME AIR TUBE AND METHOD OF MAKING

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Filed Jan. 13, 1958, Ser. No. 708,615
5 Claims. (Cl. 154—85)

This invention relates to fluid actuated flexible sectioned tubes for clutches and brakes of the ring or disk type, the invention residing principally in the provision of such tubes of substantially zero volume of interior cavity when in the closed or unactivated position and correspondingly of lower volume than other tubes heretofore provided. These tubes may be used in conventional clutch and brake mechanisms not shown, or when maximum stroke tubes are required these conventional mechanisms need be modified only to accommodate the correspondingly enlarged flex sections of my tubes as will be readily perceived by those skilled in the art.

A primary object of this invention is thus seen to be to provide an improved flexible inflatable tube having an elongated cross section which will operate from a substantially zero air volume at its initial position and yet which will withstand a considerable unit pressure during operation.

A further object is to provide an inflatable tube of the type described wherein the circular ends of the tube cross section are so constructed as to provide a considerably larger number of flexures than may be obtained with conventional clutch tubes, and which circular ends are positively prevented from creasing under flexure.

And yet another object is to provide an inflatable tube of the type described wherein the circular ends of the tube cross section are filled with a non-inflatable O ring to provide a multiple function of (1) filling the internal cavity of the tube and thus reducing the air space present when the tube is inactive and of (2) reinforcing the inner and outer periphery of the tube so that centrifugal force during use will not tend to expand the tube or move it out of position, and of (3) preventing the extreme ends of the tube cross section from creasing and causing rapid deterioration as would occur in an ordinary flat tube when collapsed, and (4) providing a mandrel about which the sections are built up in manufacturing the tube.

Another object of this invention is to provide an inflatable flexible elongated cross-section tube having horizontal fillers installed on its upper and lower surfaces to provide a substantially flat operating face to further reduce the amount of air required to engage the clutch or other operating mechanism.

And yet another object of this invention is to provide a novel method of manufacturing the tubes of this invention.

The construction and operation of the novel tube of this invention will be apparent from the following description together with the accompanying drawings in which:

FIGURE I is a top plan view of the tube of this invention.

FIGURE II is a section along line 2—2 of FIGURE I when the tube is deflated; and

FIGURE III shows the section of FIGURE II in an inflated position.

FIGURE IV is a section along the line 4—4 of FIGURE I of another embodiment of the tube of this invention in a deflated condition wherein the tube is used with a special O ring unit.

FIGURE V is the section of FIGURE IV when the tube is inflated, showing a special O ring unit in place.

FIGURE VI is a detail plan view of the unique O ring unit of the embodiment shown in FIGURES IV and V.

FIGURE VII is a cross sectional view taken along the lines 7—7 of FIGURE VI.

FIGURE VIII is a plan view of the tube of FIGURE I at the first step in its method of manufacture.

FIGURE IX is a cross sectional view along line 9—9 of FIGURE VIII.

FIGURE X shows the section of FIGURE IX after the O rings have been added.

FIGURE XI shows the section of FIGURE X with a piece of flat cover in the process of being installed to complete the bladder portion of the tube.

FIGURE XII shows the section of FIGURE XI after a layer of fabric has been cemented in place about its periphery.

FIGURE XIII shows the section of FIGURE XII in the process of having an upper and lower filler and end covers installed.

FIGURE XIV shows the completed section of the tube of this invention after curing.

FIGURE XV is a plan view of the flat disk used in an alternate method of manufacture of the tube of this invention.

FIGURE XVI is a cross section taken along the lines 16—16 of FIGURE XV.

FIGURE XVII shows the first step in the method of manufacture of this tube by placing two disks together, and the cross section here corresponds to lines 17—17 of FIGURE XV.

FIGURE XVIII shows a second step in the method of manufacture of adding O rings.

FIGURE XIX shows a third step in the method of manufacture of adding end covers.

FIGURE XX shows a fourth step in the method of manufacture of adding reinforcing fabric.

FIGURE XXI shows a fifth step in the method of manufacture and shows the completed tube assembly.

In the several figures like references indicate similar parts wherein 5—5 represents generally the flat ring portions of my tube T as bearing surfaces to contact parts of a clutch not shown, one of which portions has spud 6 communicative with cavity 7 between the flat portions 5 through which activating fluid may be introduced into and discharged from the tube as desired. About the inner and outer diameters of the flat portions, enlarged flex sections 8—8 are integrally formed, preferably reinforced by suitable cord or fabric 9 to withstand desired operating pressures within the tube. Within the flex sections there are provided circularly disposed cavities 10 of suitable sizes to provide flex section readily accommodative of the desired stroking of the tube T in a clutch. These cavities are but continuations of the extremely small substantially zero volume cavity 7 between the flat mating portions 11 of tube T.

O rings 12 and 13 are introduced into circular cavities 10 during manufacture of the tube (see FIGURES X and XVIII) to effectively fill these cavities and thus reduce the combined internal volume of tube T to substantially zero when the tube is in its initial or deflated condition as shown in FIGURE II. These O rings 12 and 13 are of a cross section to snugly fit cavities 10 when the tube in its deflated condition and in a preferred form also are larger than the central cavity 7 when the latter is expanded so that the O rings will not be dislodged out of their respective end cavities when the tube is inflated as shown in FIGURE III. The O rings will materially improve the performance of the clutch tube T by reinforcing the outer and inner circumference against centrifugal force which may either weaken the material cross section or cause it to be displaced from its normal operating position.

Spud 6 includes a hose or tube connecting means, in this case seen to be internal threaded opening 6a thru

which the activating fluid is delivered into cavities 7 and 10 for convenience by way of channel 7a which distributes the fluid within the tube. Prior to introduction of pressurized fluid, the only cavity of elongated center members 5—5 of the tube T is the very small channel 7a (and a minute air clearance between the mating surfaces 11) which permits movement of the activating fluid. Consequently the fluid volume of the tube when deflated is virtually zero between the mating faces 11 and with the insertion of O rings 12 and 13 is substantially zero for the entire tube.

Another embodiment of this invention is shown in FIGURES IV and V to comprise a tube T' substantially similar to tube T but having a wider central cavity 7 extending horizontally between circular end cavities 10 for the purpose of receiving the unique O ring unit R shown in detail in FIGURES VI and VII. Unit R includes two O ring sections 12' and 13' and an interconnecting horizontal strip 14 moulded integrally with the O ring sections into a continuous ring as shown in FIGURE VI. The advantages of this unit R over the two separate rings 12 and 13 are, firstly the convenience of handling and storage of a single unit in place of two units of different size and additionally the provision of an inner and outer ring of greater strength and resistance to deformation under centrifugal force than separate single O rings of the same size.

The novel method of manufacture of the tube of this invention may be seen by reference to FIGURES VIII–XIV inclusive to comprise basically the following steps:

(1) Moulding an open face bladder 20 of flexible material (such as rubber, neoprene, plastics and the like) into the semi-C shape shown in FIGURES VIII and IX having two sections adapted to receive O rings in position.

(2) Inserting O rings 12 and 13 of flexible or non-flexible material into the cavity 10 of bladder 20 as seen in FIGURE X.

(3) Closing the open top gap 21 of bladder 20 by placing rubber cement 22 on adjoining edges 23 of bladder 20 and a flat cover 24 (which is of similar material to the bladder; in one case: gum rubber), after conditioning both surfaces by roughening to retain the cement, and then pressing or rolling the adjoined surfaces to insure adhesion, thus forming a completed bladder 25 as shown in FIGURE XI.

(4) Covering the circumference of the bladder 25 with a reinforcing fabric 9 such as heavy loose mesh cloth (such as biased tire cord) as shown in FIGURE XII and cementing in place, and then curing the bladder by conventional vulcanizing methods, while suitable pressure is maintained inside the bladder.

(5) Adding end covers 26 and upper and lower fillers 28 as shown in FIGURE XIII and cementing all parts in place as in FIGURE XIV, and then inserting the tube in a furnace for its final curing under conventional pressures and temperatures.

The steps of manufacture of the embodiment shown in FIGURES IV and V is substantially identical to the first embodiment with the exception that O ring unit R is substituted for O rings 12 and 13 in step (2) above.

An alternate method of manufacture is shown in FIGURES XV–XXI, and consists of the initial step of placing disks 30 and 31 together as shown in FIGURE XVII. The disks 30 and 31 are molded to an identical shape, except that disk 30 only includes an opening 32 to receive a spud 6 (spud not shown in this view) as seen in FIGURE XVI.

After placing disks 30 and 31 as shown in FIGURE XVII, a pair of O rings 12 and 13 are added at the end contours 33 which are shaped to the same radius as the O rings.

The O rings 12 and 13 now act as a mandrel about which end covers 34 may be wrapped as shown in FIGURE XIX and cemented to the disks 30 and 31.

The next step is the covering of the assembly thus far with a loose mesh material such as biased tire cord 9 and cementing in place (as indicated at 28 in FIG. XXI) in such a manner as to form a protective covering, as shown in FIGURES XX and XXI after which the assembly is cured.

The final step is the bonding of upper and lower fillers 35 to the assembly of FIGURE XX as shown in FIGURE XXI and curing the unvulcanized portions of the complete assembly. It will be noted that the ends 36 of fillers 35 may not be bonded to the outer surfaces of the end members 37 in this embodiment to provide a tube with increased flexibility in the end members as more fully described in copending application Serial No. 708,614, filed January 13, 1958.

It will be obvious without additional illustration that the O ring unit R can be used in place of O rings 12 and 13 in the assembly shown in FIGURE XXI by a slight change in the procedure of manufacture, i.e., placing the disks 30 and 31 on opposite sides of the horizontal strip 14 as the first step in the manufacture of this tube assembly. It will also be understood that the fillers may be omitted from the outer faces of the parallel flat sections and correspondingly suitable contours provided in the faces of the clutch or brake mechanisms for cooperatively receiving the tubes.

From the foregoing description, it will be readily seen that there has been produced a device which substantially fulfills the objects of the invention as set forth herein.

While this specification sets forth in detail the present and preferred construction of the device, still in practice, such deviations from such detail may be resorted to as do not form a departure from the spirit of the invention, as defined by the appended claims.

Having thus described the invention, the following is claimed as new and useful, and upon which Letters Patent is desired:

1. The method of making an inflatable tube for clutches including the steps of making a pair of flat unvulcanized disk sections having minor and major diameters one of which sections has a spud opening therethrough, bringing the inner faces of the disc sections together, placing an O ring adjacent the respective minor and major diameters of the disc sections, bringing a flexible section of unvulcanized reinforced rubber around the O rings and curing the unvulcanized sections by vulcanization.

2. The method of making an inflatable tube for clutches comprising the steps of: forming an O unit with O rings of two diameters with a connecting section therebetween, forming a pair of flat disks one of which includes a spud opening, placing said disks on opposite sides of said O unit, placing end covers around O rings and cementing said covers to said disks, forming reinforcing fabric about the outer circumference of said covers, placing a spud in said spud opening, and curing the discs reinforcing fabrics and end covers.

3. The method of making an inflatable bladder, comprising the steps of: molding an open face bladder of flexible material into a semi-C shape having round end sections adapted to receive O rings, inserting O rings into said sections, cementing a flat cover over the top of the open face of said bladder and enclosing an inner cavity forming an opening in the bladder, and inserting a spud through the opening to introduce fluid therein for filling the inner cavity and inflating said bladder, and finally curing the bladder inside a confining mold.

4. The method of making an inflatable bladder, comprising the steps of: molding an open face bladder of flexible material into a semi-C shape having round end sections adapted to receive an O ring unit, inserting an

O ring unit into said sections, cementing a flat cover over the top of the open face of said bladder and enclosing an inner cavity, forming an opening in the bladder, and inserting a spud through the opening to introduce fluid therein for filling the inner cavity and inflating said bladder.

5. The method of making an inflatable tube for clutches and the like comprising the steps of: molding an open face bladder of flexible material into a semi-C shape having round end sections adapted to receive O rings, inserting O rings into said sections, cementing a flat cover over the top of the open face of said bladder and forming an inner cavity therein, forming an opening in the bladder, inserting a spud through the opening to introduce fluid therein for filling the inner cavity, cementing a reinforcing fabric around the outer circumference of said bladder, cementing end covers over the fabric at each end of said bladder, cementing upper and lower fillers on the bladder between the end covers, and then curing the bladder, the covers and the fillers.

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